



JOHN F. KENNEDY
SPACE CENTER

SP-172
December 30, 1964

N 65-85054

FACILITY FORM 802

(ACCESSION NUMBER)

34
mx 56503
(AD NUMBER)

(THRU)

NONE
(CODE)

(CATEGORY)

SA-9 LAUNCH VEHICLE
MEASURING SYSTEMS AND ASSOCIATED CHECKOUT GSE DESCRIPTION

MEASURING BRANCH, VE3

JOHN F. KENNEDY SPACE CENTER, NASA

SP-172

SA-9 LAUNCH VEHICLE

MEASURING SYSTEMS AND ASSOCIATED CHECKOUT GSE DESCRIPTION

By

MEASURING BRANCH, VE3

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
I INTRODUCTION	1
II VEHICLE MEASURING SYSTEM.....	2
A. General Description	2
B. Differences From SA-7	2
C. Test Procedures.....	8
III MICROMETEOROID MEASUREMENT SYSTEM.....	10
A. Systems Description	10
IV LAUNCH CONTROL CENTER MEASURING SYSTEM.....	
A. General.....	14
B. Description of Measurements Displayed in the LCC...	14
C. General Test Procedures and Launch Preparations,....	16
V COMBUSTION STABILITY MONITOR SYSTEM	17
A. General Description.....	17
B. Differences From SA-7	17
VI VEHICLE FIRE DETECTION MONITOR SYSTEM	18
A. General Description	18
B. Differences From SA-7	18
VII INFLIGHT FIRE DETECTION MONITOR SYSTEM	19
A. General Description	19
B. Differences From SA-7	19
VIII SYSTEM CALIBRATION AND TEST.....	21
A. General.....	21
B. Vehicle Analog (Hardwire) Measurements	21
C. Vehicle Digital Data Acquisition System Measurements.	23
APPROVAL	30
DISTRIBUTION	31

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1	Micrometeoroid Measurement Capsule.....	11
2	MMC Measuring System	13
3	Typical Inflight Fire Detection Monitor (IFDM), Block Diagram	20
4	LC 37 Calibration and Test Equipment, Block Diagram	22
5	Typical DDAS,Block Diagram	24
6	DDAS Receiving Station Assembly, Model DRS-1	25
7	Digital Data Aquisition System, Block Diagram	26
8	Digital Data Calibration System Equipment	27
9	Digital Data Calibration System, Block Diagram.....	28

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
1	Measurement Breakdown, SA-9 Vehicle	3
2	Changes to SA-9 Vehicle Measuring System.....	4
3	Measuring System Tests.....	8

SECTION I INTRODUCTION

Section II describes the on-board instrumentation system for Saturn Launch Vehicle SA-9 (S-I, S-IV, and Instrument Unit) and the measuring ground support equipment. Measuring Branch test procedures are listed in tabular form. Section II also discusses the major differences between SA-7 and SA-9 on-board measuring systems. S-I, S-IV, and Instrument Unit (IU) parameters measured, together with those displayed in the Launch Control Center, are listed in tabular form in Section II.

Section III discusses the Micrometeoroid Measurement Capsule (MMC). Section IV describes Launch Control Center displays. The Combustion Stability Monitor and the Fire Detection Systems are covered in Sections V through VII.

SECTION II VEHICLE MEASURING SYSTEM

A. GENERAL DESCRIPTION

The on-board vehicle measuring system consists of transducers and signal conditioning equipment for those transducers requiring it. Transducer outputs in the 0-5 volt range are sent directly to the telemeter input.

There are 30 measuring racks (23 in the S-I stage and 7 in the IU) with space for 20 signal conditioners per rack. These signal conditioners are transistorized plug-in modules that may easily be replaced if operation is erratic during prelaunch checkout. Each signal conditioner has a built-in calibrate circuit which enables a known input to be applied to the conditioner. The conditioner output is adjustable to specified calibration values (high and low checkpoints) supplied by Astrionics Division, MSFC. Calibration modes may be selected manually through microswitches on the front of the module, or remotely through the Remote Automatic Calibration System (RACS). The RACS supplies a coded signal from the ground to the vehicle. Logic modules in the vehicle decode this signal and energize the proper signal conditioner. The on-board RACS equipment is used in prelaunch checkout only.

Table 1 lists parameters covered by the vehicle measurement system.

B. DIFFERENCES FROM SA-7

The IU has been altered significantly for SA-9. The pressurized section (area 802) has been removed and equipment is mounted around the periphery of the unit. All measuring racks have been moved from the IU to the forward area of the S-IV stage. These racks are connected to the ground ECS system via pneumatic lines and are air conditioned until lift-off. The ECS is disconnected at lift-off and the racks vent down through vent ports as the vehicle gains altitude.

The Vehicle Measuring Section has assumed responsibility for the Q-ball system for SA-9 and subsequent. The Q-ball is a nose-mounted airflow direction sensor on top of the Launch Escape Tower. Outputs are three differential pressures and one ram air pressure measured on the spherical sensing surface. These measurements provide sufficient information to determine angle of attack, angle of sideslip, dynamic pressure and ram air density.

The Q-ball contains an internal heating blanket which maintains temperature control of the unit during ground checkout operations. The heater is disconnected at vehicle lift-off. Instrumentation is provided for monitoring the Q-ball internal temperature during ground checkout and in flight.

Significant SA-9 measurement changes for the S-I and IU stages compared to SA-7 are listed in table 2.

TABLE 1. MEASUREMENT BREAKDOWN, SA-9 VEHICLE

Desig.	System	Vehicle Units			Displayed in Blockhouse		
		S-I	IU	S-IV	S-I	IU	S-IV
A	Propulsion	26	0	12	0	0	0
C	Temperature	299	21	108	83	10	7
D	Pressure	128	12	124	26	2	8
E	Strain & Vibration	108	35	35	8	0	0
F	Flight Mechanics	13	11	11	0	0	0
G	Steering Control	4	40	0	4	0	0
H	Stabilized Platform	0	17	0	0	10	0
I	Guidance	0	14	3	0	0	0
J	RF & Telemetry	0	9	0	0	0	0
K	Signals	40	25	57	0	0	12
L	Miscellaneous	3	2	17	0	0	8
M	Voltage, Current, Frequency	14	30	38	0	0	0
	TOTALS	635	216	405	121	22	35

TABLE 2. CHANGES TO SA-9 VEHICLE MEASURING
SYSTEM

Measurement Number	Measurement Description	Deleted	Added	Remarks
C286-3	Temp Engine Nozzle Surface T-Cal		x	More rugged gauge enables study of heat flux in exposed areas.
C287-3 C288-3	Temp Heat Exchanger Surface T-Cal		x	Same as C286-3.
C289-3 thru C294-3	Temp Aspirator Surface T-Cal		x	Same as C286-3.
C295-7 thru C300-7	Temp Engine Nozzle T-Cal		x	Same as C286-3.
D189-11	Pressure Camera Purge System	x		No longer required.
D190-11	Pressure TV Camera Purge System	x		No longer required.
E226-11 thru E228-11	Vibration Upper Structure (longitudinal, pitch & yaw)		x	Required to determine spider beam web vibration at fin I in longitudinal axis.
E274-4 E275-4 E276-4	Vibration, Yaw Actuator (longitudinal, pitch, & yaw)	x		No longer required
E295-9 thru E326-9	Strain, Skirt	x		36 strain measurements on S-I skirt deleted because telemetry data verified theoretical design calculations.
E364-2	Vibration Thrust Chamber Dome, Lat.		x	Output from transducer for measurement E 11-2 used for R & D purposes with Spectrum Analyzer.

TABLE 2. CHANGES TO SA-9 VEHICLE MEASURING
SYSTEMS (Cont.)

Measurement Number	Measurement Description	Deleted	Added	Remarks
E365-4	Vibration, Turbine Gear Box		x	Output from transducer for measurement E 12-4 used for R & D purposes with Spectrum Analyzer.
E366-9	Vibration, Shear Panel, Longitudinal		x	Output from transducer for measurement E 136-9 used for R & D purposes with Spectrum Analyzer.
E367-1	Vibration, Turbine Gear Box		x	Output from transducer for measurement E 12-1 used for R & D purposes with Spectrum Analyzer.
L28-9	Sound Intensity		x	Required to measure noise level in engine compartment.
L41-11 thru L48-11	Camera Frame Rates	x		No longer required.
L62-11 & L63-11	Sound Intensity	x		No longer required.
---	6 Temperature Measurements	x		Deleted due to Instrument Unit design change.
---	2 Pressure Measurements	x		
---	28 Vibration Measurements	x		
---	2 Sound Intensity Measurements	x		
E373-900 E374-900	Vibration, Apollo Structure	x		Apollo s/c not flown on SA-9.
H31-802	Temperature Monitor ST-124 Gimbal	x		Deleted due to Instrument Unit design change.

TABLE 2. CHANGES TO SA-9 VEHICLE MEASURING
SYSTEMS (Cont.)

Measurement Number	Measurement Description	Deleted	Added	Remarks
I21-802	Digital Command Scan	x		No longer required.
L49-801 thru L52-802	Horizon Sensor 1, 2, 3, 4	x		Horizon Sensor not flown on SA-9.
L55-801 thru L58-801	Horizon Sensor AC Monitor 1, 2, 3, 4	x		Horizon Sensor not flown on SA-9.
L69-900	Sound Intensity, Apollo	x		Apollo s/c not flown on SA-9.
- - - - - - - - - - - -	13 Temperature Measurements 3 Pressure Measurements 22 Vibration Measurements 1 Sound Intensity Measurement		x x x x	Required due to Instrument Unit design change.
F29-900	Density, Ram Air Density Gauge		x	High altitude air density measurements.
F30-900	Density Gauge Range Indication		x	High altitude air density measurements.
M53-802 thru M60-802	8 Power Measurements on IU Telemeters.		x	Measurement of Instrument Unit Telemeter Antenna VSWR.
- - -	7 Vibration Measurements 1 Sound Intensity Measurement		x	Requirement for MMC.

TABLE 2. CHANGES TO SA-9 VEHICLE MEASURING
SYSTEMS (Cont.)

Measurement Number	Measurement Description	Deleted	Added	Remarks
K89-900 thru K106-99	18 Firing & Separation Signals from MMC		x	Requirement for MMC.
M62-900 & M63-900	Voltage, MMC Deployment Motors 1 & 2		x	Requirement for MMC.
K108-900 & K109-900	Launch Escape Tower Arm & Command		x	Arm & Jettison Command from LET

Major differences for the S-IV stage between S-IV-7 and S-IV-9 are:

1. S-IV-7 measurements not included on S-IV-9

C680-408 Lox Tank Differential Gas Temp
 C699-410 Temp, Power Distribution Box, Forward Interstage
 C700-410 Temp, Conditioner Rack, Forward Interstage
 C701-410 Temp, Transmitter Rack, Forward Interstage

2. Measurements not on S-IV-7

C702-417 Helium Heater LH₂ Injector Temp, Injector 1
 C703-417 Helium Heater LH₂ Injector Temp, Injector 2
 C704-417 Helium Heater Lox Injection Temp
 D645-410 External Skin Pressure, Forward Interstage Sta. 460
 D651-407 Helium Heater LH₂ Injector Pressure, Injector 1
 D652-407 Helium Heater LH₂ Injector Pressure, Injector 2
 D653-407 Helium Heater Lox Injector Pressure, Injector 1
 D654-407 Helium Heater Lox Injector Pressure, Injector 2

C. TEST PROCEDURES

Tests applicable to the vehicle on-board measuring system are listed in table 3. The tests verify operation and calibration of specific systems, and prepare the measuring system for tests.

TABLE 3. MEASURING SYSTEM TESTS

TEST NUMBER	TEST
2LSII-701	Strain Measurements
2LSII-702	Turbine Tachometer Measurement
2LSII-703	Liquid Level Measurement
2LSII-705	Inflight Fire Detection Monitor
2LSII-706	Rough Combustion Cutoff Measurement
2LSII-707	Fire Detection Measurements
2LIUI-701	Stabilized Platform Measurements
2LIUI-702	Power Measurements
2LIUI-703	Guidance Measurements
2LLVI-701	Structure Measuring Station Preparations for Test Support, LCC 37

TABLE 3. MEASURING SYSTEM TESTS (Cont.)

TEST NUMBER	TEST
2LLVI-702	Oscillograph Recording Structure Measuring Station, LCC 37
2LLVI-703	Temperature Measurements
2LLVI-704	Pressure Measurements
2LLVI-705	Vibration and Sound Intensity Measurements
2LLVI-706	Steering Measurements
2LLVI-707	Signal Measurements
2LLVI-708	Voltage Measurements
2LLVI-709	Hydraulic Systems Measurements
2LLVI-710	Angular Velocity Measurements
2LLVI-711	Current Measurements
2LLVI-712	Acceleration Measurements
2LLVI-713	Blockhouse Measurements
2LLVI-714	Launch Control Center Measurements

SECTION III

MICROMETEOROID MEASUREMENT CAPSULE

A. SYSTEMS DESCRIPTION

The payload includes the Micrometeoroid Measurement Capsule (MMC), which is permanently attached to the S-IV stage and housed in a service module during powered flight. After orbital insertion, explosive bolts and springs release the service module and MMC restraints and the MMC deploys (figure 1). Deployment information as well as vibration of MMC mountings and tie points is transmitted through the IU telemeters. There are 28 measurements: 7 vibrations, 1 sound intensity, 2 voltages, and 18 deployment status types.

The MMC will determine the size and direction of travel of medium sized meteoroids in near-earth space, store this information, and transmit it on command. In addition to the meteoroid detection system there are systems for providing power, processing data, sensing and controlling temperature, determining MMC attitude, monitoring housekeeping functions, and telemetering this information to ground stations.

1. Detector System. The meteoroid detector system consists of 104 capacitor type panels mounted on each wing. Each panel is connected to a detector disconnect unit by flat strip cabling. The disconnect unit is ground commandable and is used to eliminate shorted panels as well as in other troubleshooting applications.

A meteoroid striking a detector panel causes a momentary short which is fed into a coding matrix. Information as to which panel was hit is fed into recharge amplifiers which in turn feed the information in analog form to a real-time PAM telemeter. The information is also fed in digital to a core storage unit. In addition, the memory is fed the total hit count of each of the three thicknesses of panels (0.016, 0.008, and 0.0015 inch).

2. Temperature System. The temperature system consists of two thermistor panel sensors, a two-channel radiation sensor (electron spectrometer with conversion unit to convert pulsed output to DC analog form), and four thermal coating sensors. These sensors are connected to a commutator in the temperature processing unit. The processing unit converts the analog inputs to digital and feeds this information as required to both core storage and to a real-time PCM commutated telemeter. There are three processing unit operation modes with four 8 bit words as an output. These are, panel and radiation sensor information, thermal coating sensor, and a system calibration.

The temperature system also contains a number of mechanical louvers which control the internal temperature of the electronics canister. Each louver is controlled by a bimetallic spring which acts as both sensor and actuator. Thus, if a hot spot exists within the canister, the louvers in that area will open while those in other areas will remain closed. The degree of opening is proportional to the temperature of the bimetallic spring.

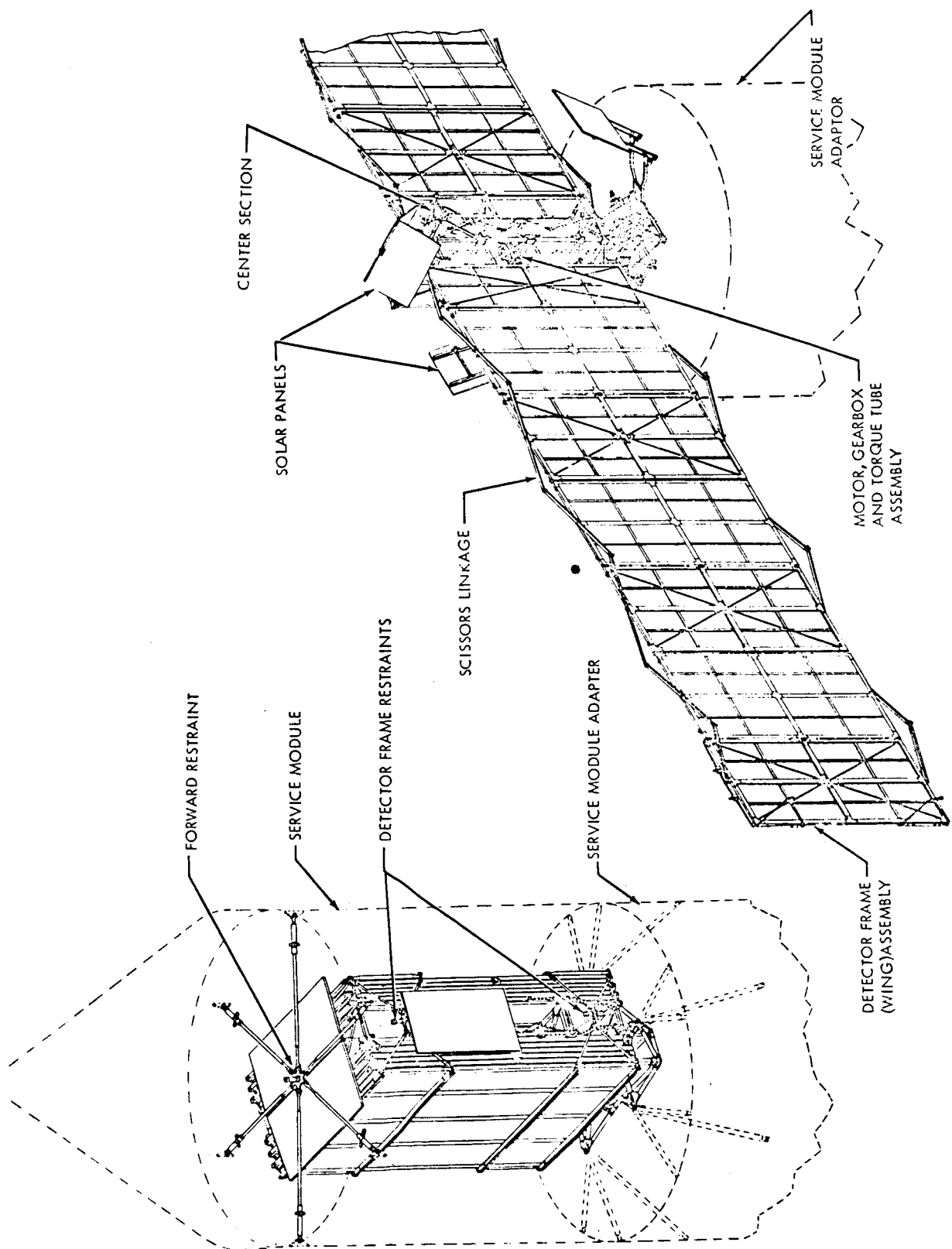


Figure 1. Micrometeoroid Measurement Capsule

3. Housekeeping Sensors. Sensors throughout the MMC provide status information on critical temperatures, voltages, currents, and on/off functions. Most of this information is transmitted via the PAM telemeter.

4. Data System. The data system consists of all timing, storage, and control elements necessary to read fixed format data into the communications system in a prescribed sequence. Intermediate storage at the interface of the various sensor systems is provided by core-transistor logic registers. Upon command, a given word is read out of a register and into both the main storage element and the PCM commutator. The main storage element is a 30,080 bit core memory which stores data for from six to eight hours of normal operation between ground commanded readouts.

A block diagram of the total measurement system is shown in figure 2.

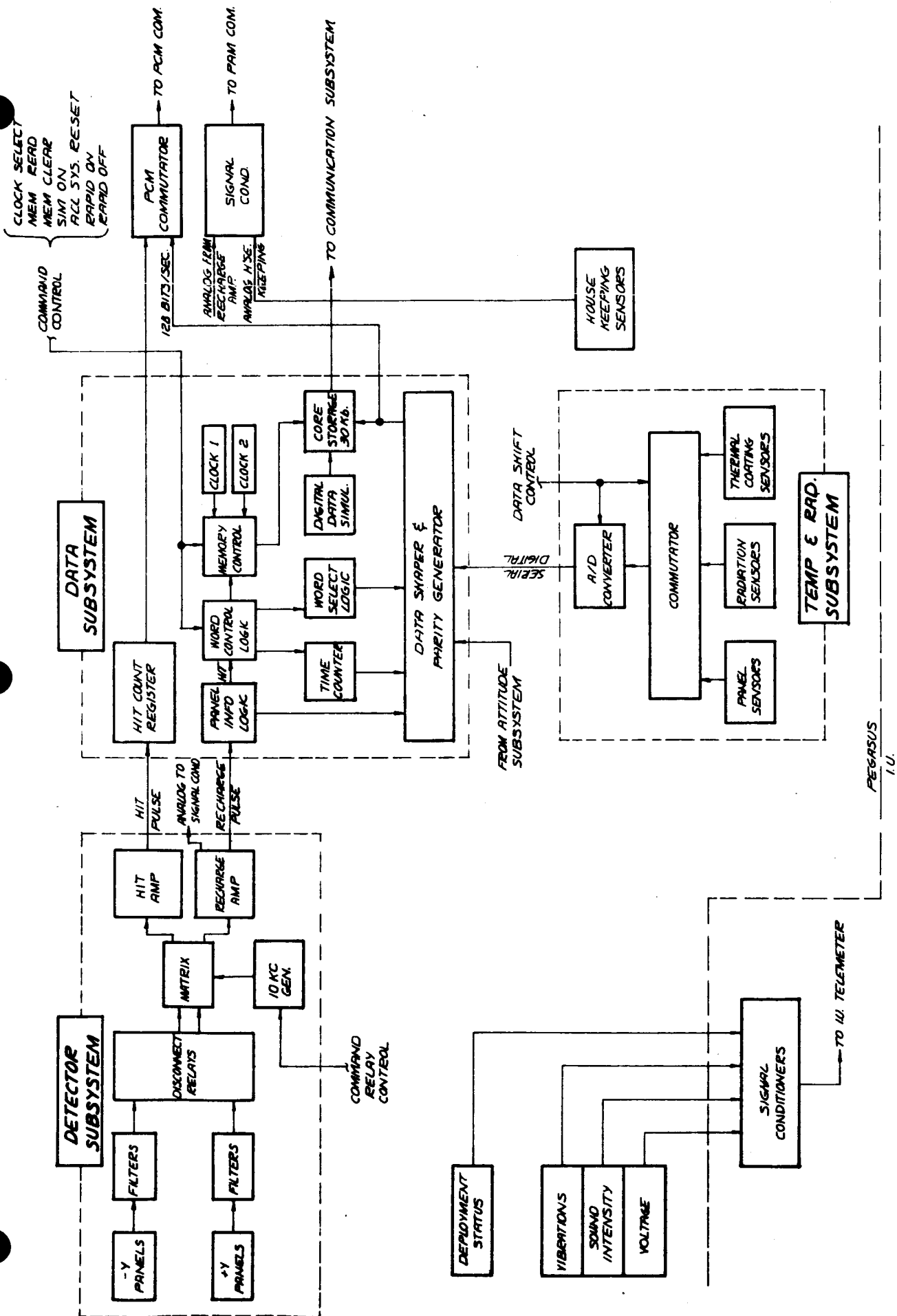


Figure 2. MMC Measuring System

SECTION IV LAUNCH CONTROL CENTER MEASURING SYSTEM

A. GENERAL

The Launch Control Center displays 161 measurements. These include 91 hardwire and 18 DDAS measurements of S-I stage, 32 hardwire of S-IV stage, 12 hardwire and 4 DDAS measurements of the IU, and 8 ground measurements of GSE.

The GSE used in calibrating, recording, and monitoring launch vehicle critical measurements consists of strip chart recorders, direct and optical oscillographs, and the necessary amplifiers and calibration equipment. The strip chart recorders and direct write oscillographs are primarily used where high accuracy and low frequency response are required. The optical oscillographs record the high frequency type measurements.

B. DESCRIPTION OF MEASUREMENTS DISPLAYED IN THE LCC

1. S-I Hardwire Measurements. Following are the 91 measurements transmitted by hardwire to the LCC:

Lox Pump Inlet Temperatures, Engines 1-8	8
Lox Pump Bearing Temperatures, Engines 1-8	8
Gear Case Lubricant Temperatures, Engines 1-8	8
Turbine Spinner Case Temperatures, Engines 1-8	8
Fuel Tank Temperatures and Pressure	5
Helium Sphere Temperature and Pressure	2
High Pressure Sphere Pressure	1
Control Equipment Supply and Regulator Pressures	2
Hydraulic Oil Levels, Temperatures and Pressures	12
Instrument Compartment Temperatures	2
Gas Generator Fuel and Lox Injector Pressures, Engines 1-8	16
Gas Generator Chamber Temperatures, Engines 1-8	8
Turbine Speed, Engines 1-8	8
Lox Tank Pressure	1

Destruct EBW 2

2. S-I DDAS Measurements. The following are the 18 measurements from the Digital Data Acquisition System (DDAS). DDAS measurements were not specified by MSFC but were requested by KSC for safety and operational support.

S-I/S-IV Interstage Temperatures	6
D10 and D20 Battery Currents	2
Gox Control Valve Temperature	1
Ambient Air Temperature	1
Lox Pump Inlet Pressures	8

3. IU Hardwire Measurements. The 12 measurements transmitted from the IU are:

ST-124 Air Bearing Supply Temperature and Pressures	3
Guidance Computer Inlet Cooling Duct Temperature	1
GSP-24 Inlet Cooling Duct Temperature	1
Battery 1 and 2 Internal Temperatures	2
IU Exit Cooling Temperatures	1
IU Ambient Temperatures 1, 2, 3, 4	4

4. IU DDAS Measurements. IU DDAS measurements (4) are:

D10 and D20 Battery Currents	2
Guidance Computer and Processor Temps	2

5. Ground Measurements. The eight ground measurements displayed in the LCC are:

Lox and RP-1 Annin Valve Positions	2
Lox and RP-1 Annin Valve Signal Pressures	2
Swing Arms	4

6. S-IV Measurements. The 32 S-IV measurements are listed below. Recording and calibration equipment is furnished by K-VE3.

Lox Pump Inlet Temperatures, Engines 1-6.	6
---	---

Lox Tank Ullage Pressure	1
LH ₂ Tank Ullage Pressure	1
Lox Main Line Pressure	1
LH ₂ Main Line Pressure	1
Lox Replenish Line Pressure	1
LH ₂ Replenish Line Pressure	1
Helium Sphere 2 Pressure and Temperature	2
Lox Fine Mass	1
Lox Coarse Mass	1
LH ₂ Fine Mass	1
LH ₂ Coarse Mass	1
Common Bulkhead Pressure	1
Helium Heater Inlet Pressure	1
Ullage Rockets EBW 1-8 Voltage	8
EBW 1 & 2 CDR Voltage	2
Jettison 1 & 2 (Ullage Rockets) Voltage	2

C. GENERAL TEST PROCEDURES AND LAUNCH PREPARATIONS

Launch preparations include end-to-end calibration (whenever possible), checkout of ground recorders, use of remote automatic calibrate systems, and actuation of 100 cps oscillator system.

SECTION V COMBUSTION STABILITY MONITOR SYSTEM

A. GENERAL DESCRIPTION

The Combustion Stability Monitor (CSM) system is preset to generate an engine cutoff signal when high frequency combustion instability exceeds 100G rms for approximately 100 milliseconds. Frequency range of operation is from 900 cps to 6 kc.

During launch, the CSM system is active from ignition start to launch commit. At launch commit, the CSM cutoff circuitry is automatically deactivated.

B. DIFFERENCES FROM SA-7

The system for SA-9 is the same as that used for SA-7.

SECTION VI
VEHICLE FIRE DETECTION MONITOR SYSTEM

A. GENERAL DESCRIPTION

The Blockhouse Fire Detection Monitor system is preset to cut off if the S-I engines temperature rise-rate exceeds 60 degrees C per second for 0.5 second. The system is armed for automatic cutoff capability from approximately T-10 minutes until launch commit.

B. DIFFERENCES FROM SA-7

The system for SA-9 is the same as that used for SA-7.

SECTION VII INFLIGHT FIRE DETECTION MONITOR SYSTEM

A. GENERAL DESCRIPTION

The S-I engine compartment is monitored for over-temperature rate indication by the Inflight Fire Detection Monitor (IFDM) system. The IFDM is a passive rise-rate temperature-indicator system consisting of 80 thermocouples with associated amplifiers and Schmitt trigger circuits. (See figure 3). If the temperature rise-rate exceeds 60 degrees C per second for 0.5 second, a discrete 5 volt signal is sent to the RF tele-meter package and the LCC via the DDAS.

The LCC monitor consists of an indicator panel which displays each thermocouple location relative to engine position. If the rise-rate temperature is excessive for any thermocouple, the appropriate panel indicator lights.

The IFDM system will monitor continuously during propellant loading and from launch through burnout.

This system is unique: use of a submultiplexer makes it possible to accommodate 80 measurements in the space normally required for eight in the vehicle DDAS system.

B. DIFFERENCES FROM SA-7

The IFDM system for SA-9 is the same as that used for SA-7.

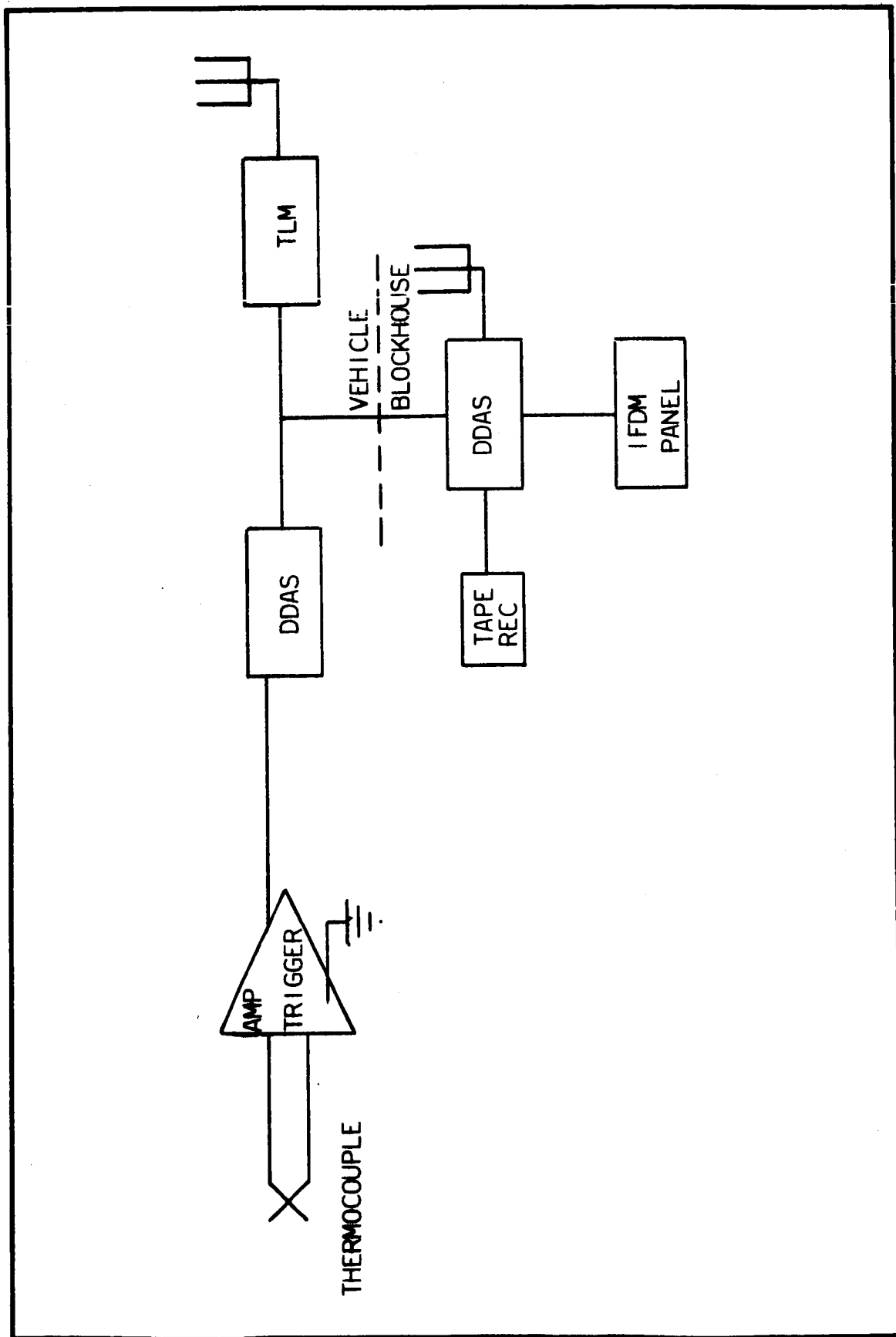


Figure 3. Typical Inflight Fire Detection Monitor (IFDM), Block Diagram

SECTION VIII SYSTEM CALIBRATION AND TEST

A. GENERAL

The Vehicle Measuring Section uses various items of GSE to calibrate and test the measuring system and to support vehicle operations. Among the more important are:

- Remote Pneumatic System
- Remote Automatic Calibration System (RACS)
- Calibration Consoles (5)
- Control Console (1)
- IBM 407 Programming Machine
- Digital Data Acquisition System (DDAS)
- Digital Data Calibration System (DDCS)
- Crossbar Select Units
- Various Distributors/Relay Boxes

This equipment is in and around the service structure measuring station as shown in figure 4.

Measuring Station GSE for SA-9 has been changed in the DDCS/IBM 407 system area. See paragraph C for details.

The vehicle measuring system is calibrated and tested using vehicle analog (hard-wire) or DDAS signals.

B. VEHICLE ANALOG (HARDWIRE) MEASUREMENTS

A relay unit is inserted between the vehicle signal lines and the telemeters. This unit has cables to the measuring station crossbar units and the telemeters, and allows switching signals as required.

The appropriate signals are switched to the measuring station where they are routed to one of five calibration consoles via the crossbar units.

Each measurement is calibrated manually. The signal conditioning unit (if used) for the measurement is energized to the selected mode (high, low or run) via the RACS. The run mode is the normal state of the conditioner. High and low modes are selected checkpoints which must compare with calibration data within selected tolerances. The selected mode values are observed on meters or recorders and compared with calibration data supplied by the Astrionics Division, MSFC. Appropriate action (amplifier adjustment, replacement of components, etc) insures that values are within tolerances.

The IBM 407 and the control console are used with one calibration console for automatic checkout. This mode provides a fast method of checking all vehicle measurements. Automatic operation bypasses and locks out manual selection and substitutes the control functions necessary to automatically operate the system. Information is fed to the 407

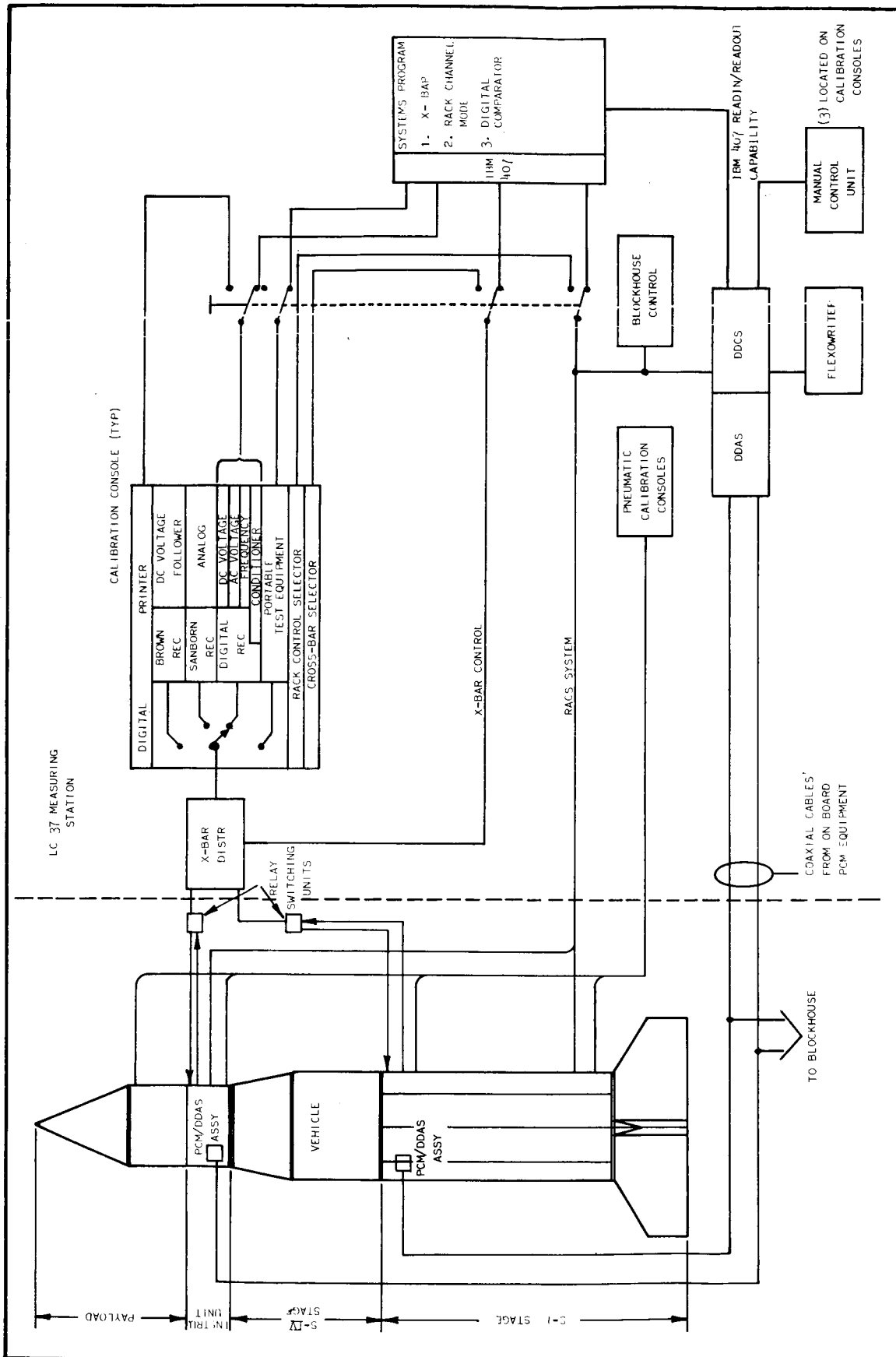


Figure 4 . LC 37 Calibration and Test Equipment, Block Diagram

punched cards. This provides the necessary signals to select a measurement, energize it to the proper mode, compare the measured values to calibration values, and print out this information. Out-of-tolerance measurements are indicated by an asterisk. The time required for a complete IBM checkout of the S-I and IU stages is 45 and 15 minutes respectively.

C. VEHICLE DIGITAL DATA ACQUISITION SYSTEM MEASUREMENTS

Besides analog measurements, various signals are routed to vehicle DDAS equipment. Coaxial cables connect the S-I and IU stage DDAS assemblies (figures 4 and 5) to the DDAS ground stations located in the LCC37 and the service structure measuring station, LC37.

The DDAS ground station (figure 6) is a data processing system which receives a stage DDAS signal and provides data in a form readily usable by other portions of the ground facility. DDAS basic internal functions are demodulation, clock regeneration, digital data reconstruction, channel demultiplexing, serial to parallel conversion buffering, and digital to analog conversion. The station provides outputs in either analog or digital form.

A block diagram of the DDAS ground station is shown in figure 7. The stage DDAS output signal is transmitted via coaxial cable to the coaxial selector switch. The output of this switch feeds the Receiver/Demodulator. The digital signal is then processed by the Digital Signal Synchronizer. Next the signal is clocked into a shift register in the correlator.

Demultiplexing counters, which correspond to counters in the stage telemetry system, are in the Data Control Panel. Channel selection pulses derived from these counters are patched via the Data Switch Panel to digital-to-analog converters or may be selected manually at the Quick Look Panel.

The system is presently set up to receive the 7200 words/second (10 bits/word) Saturn format. The station will operate at bit rates up to approximately 144,000 bits/second.

The vehicle DDAS system introduces a 24 bit "bias" into the transmitted information. This error was eliminated by a modification in the Digital Data Calibration System.

The Digital Data Calibration System (DDCS) is used to interface with the ground DDAS station and the on-board RACS equipment to calibrate launch vehicle measurements. The equipment consists of drawer assemblies and power supplies as shown in figure 8. The system can be operated in either the manual calibration mode or the automatic scan mode. During manual calibration three operators can use the equipment simultaneously. A functional block diagram of the system is shown in figure 9.

Actual calibration of the DDAS data is performed by comparing the incoming DDAS data with stored calibration data. (Information is fed into the DDCS memory from punched

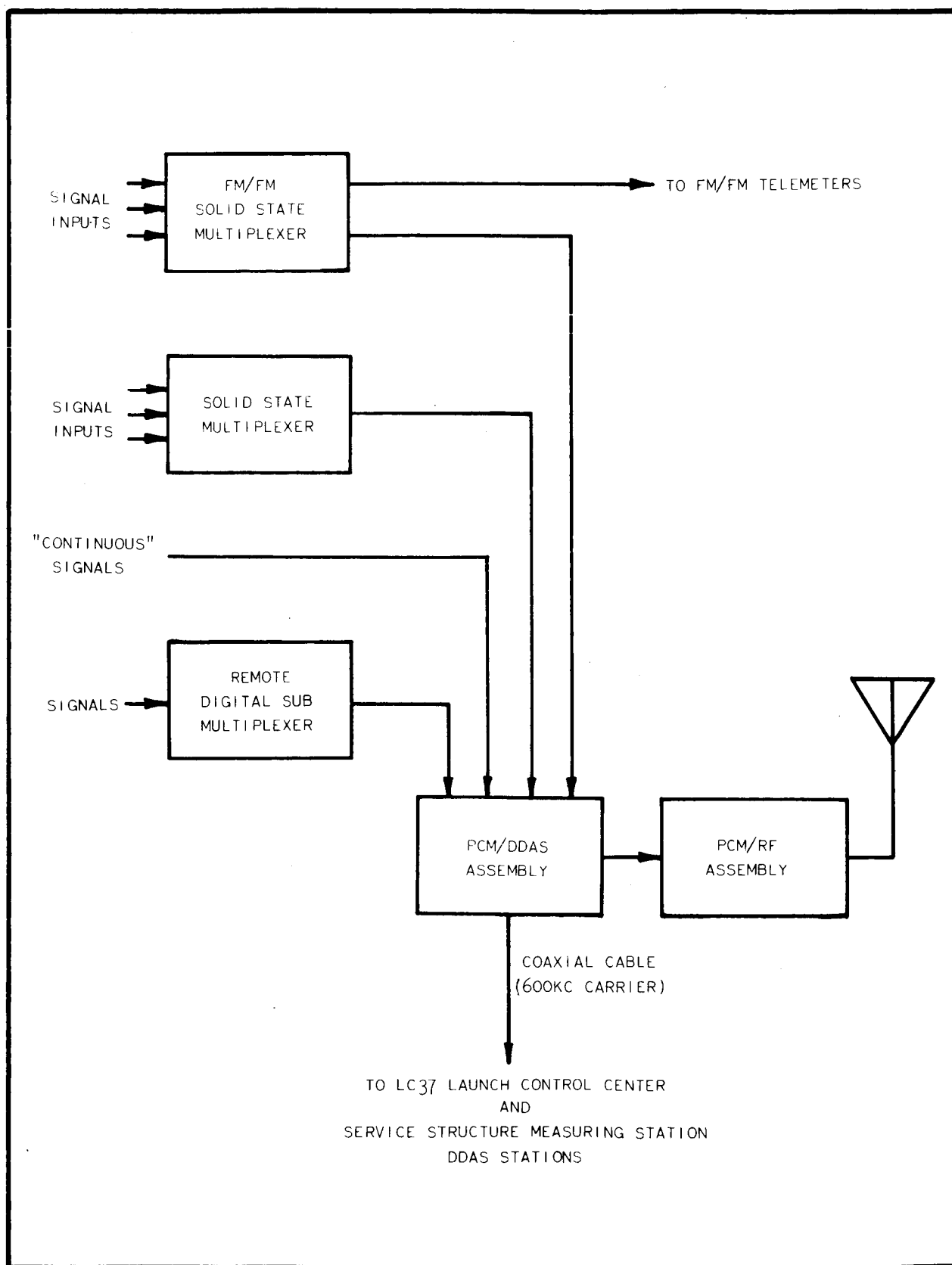


Figure 5. Typical DDAS, Block Diagram

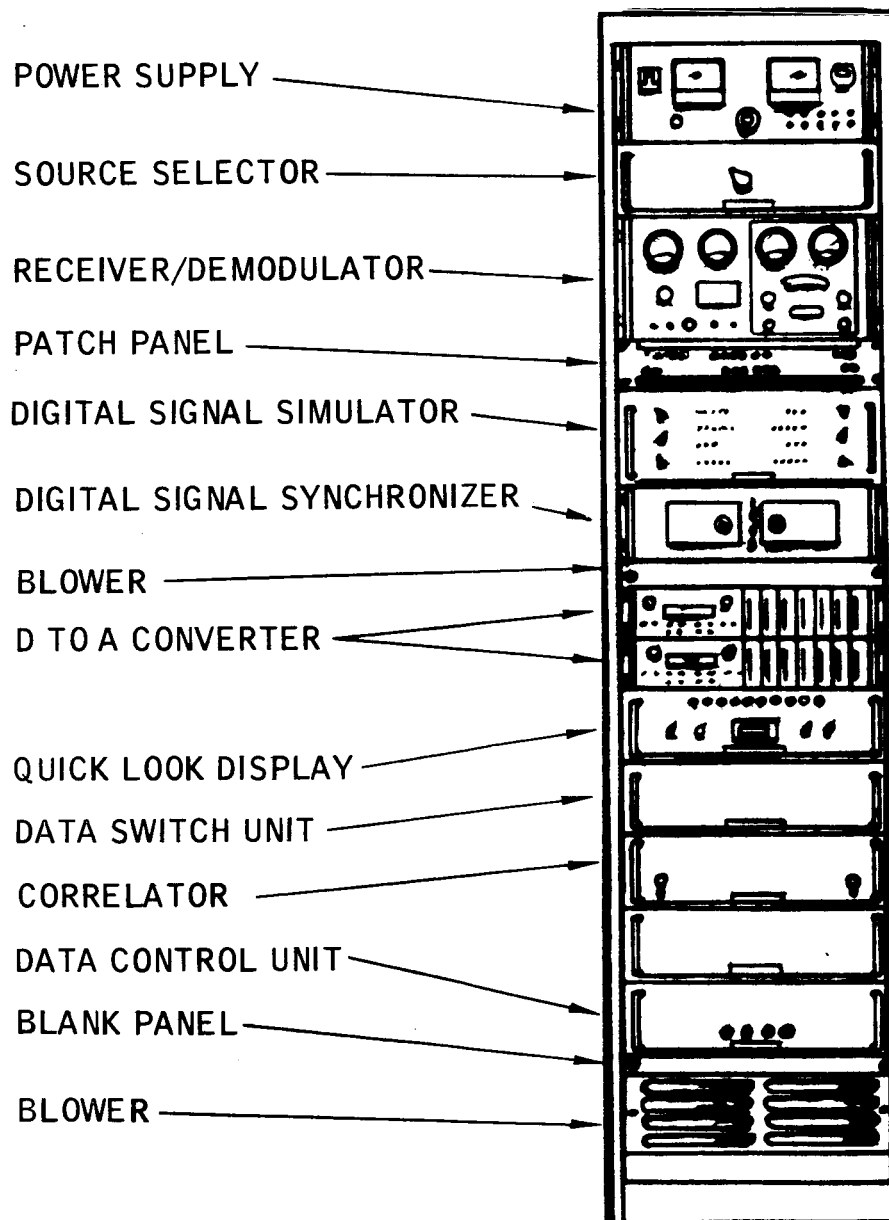


Figure 6. DDAS Receiving Station Assembly, Model DRS-1

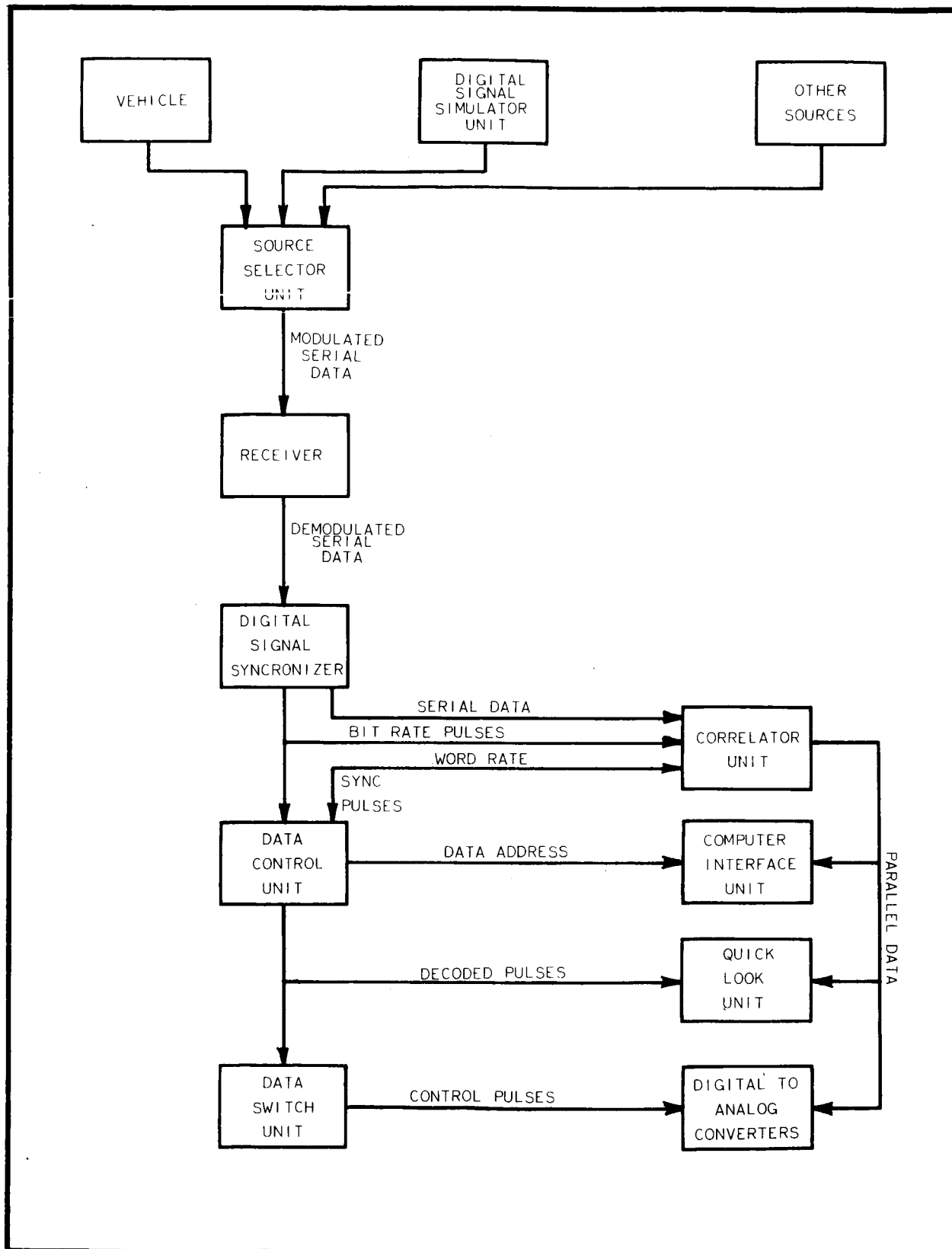


Figure 7. Digital Data Acquisition System, Block Diagram

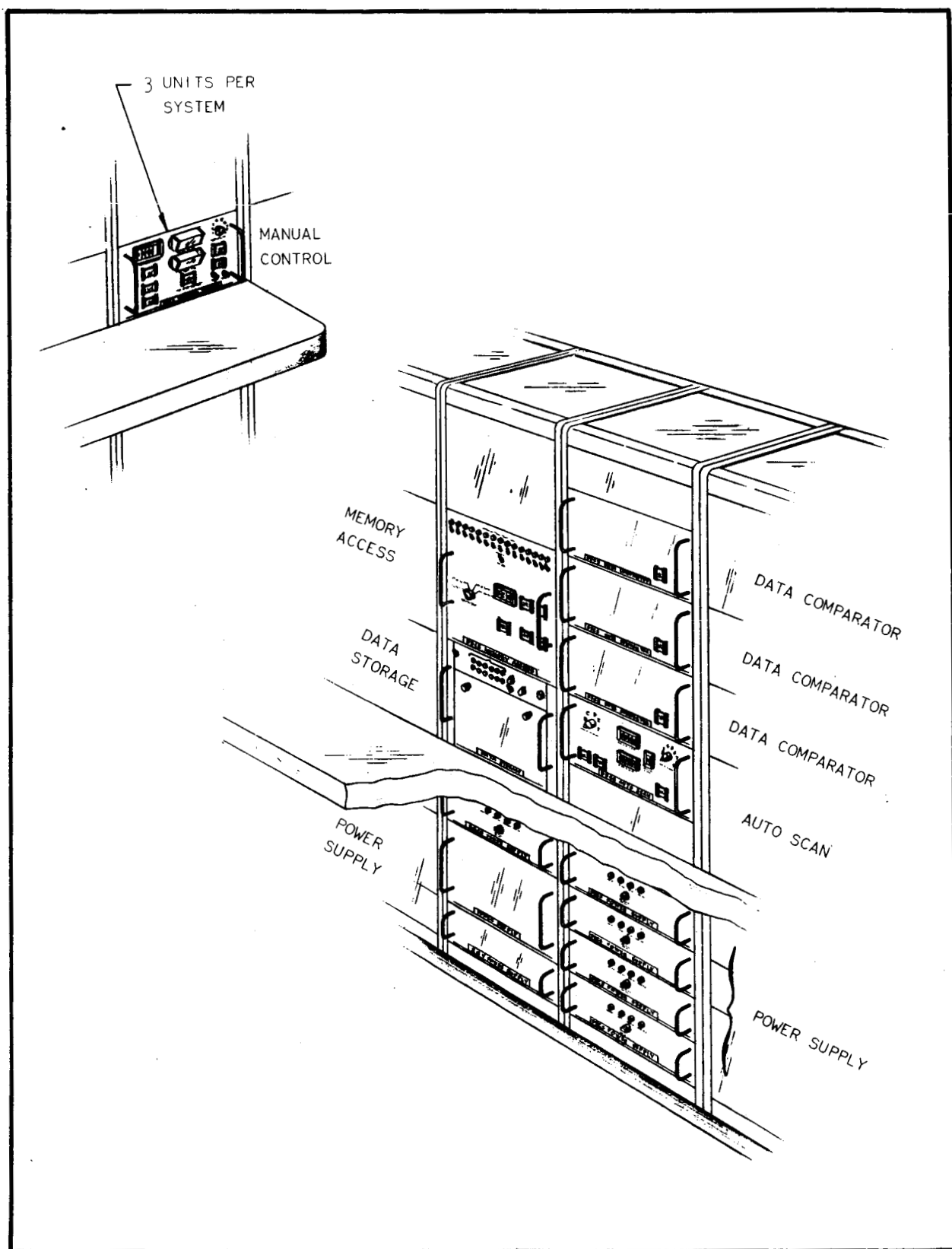


Figure 8. Digital Data Calibration System Equipment

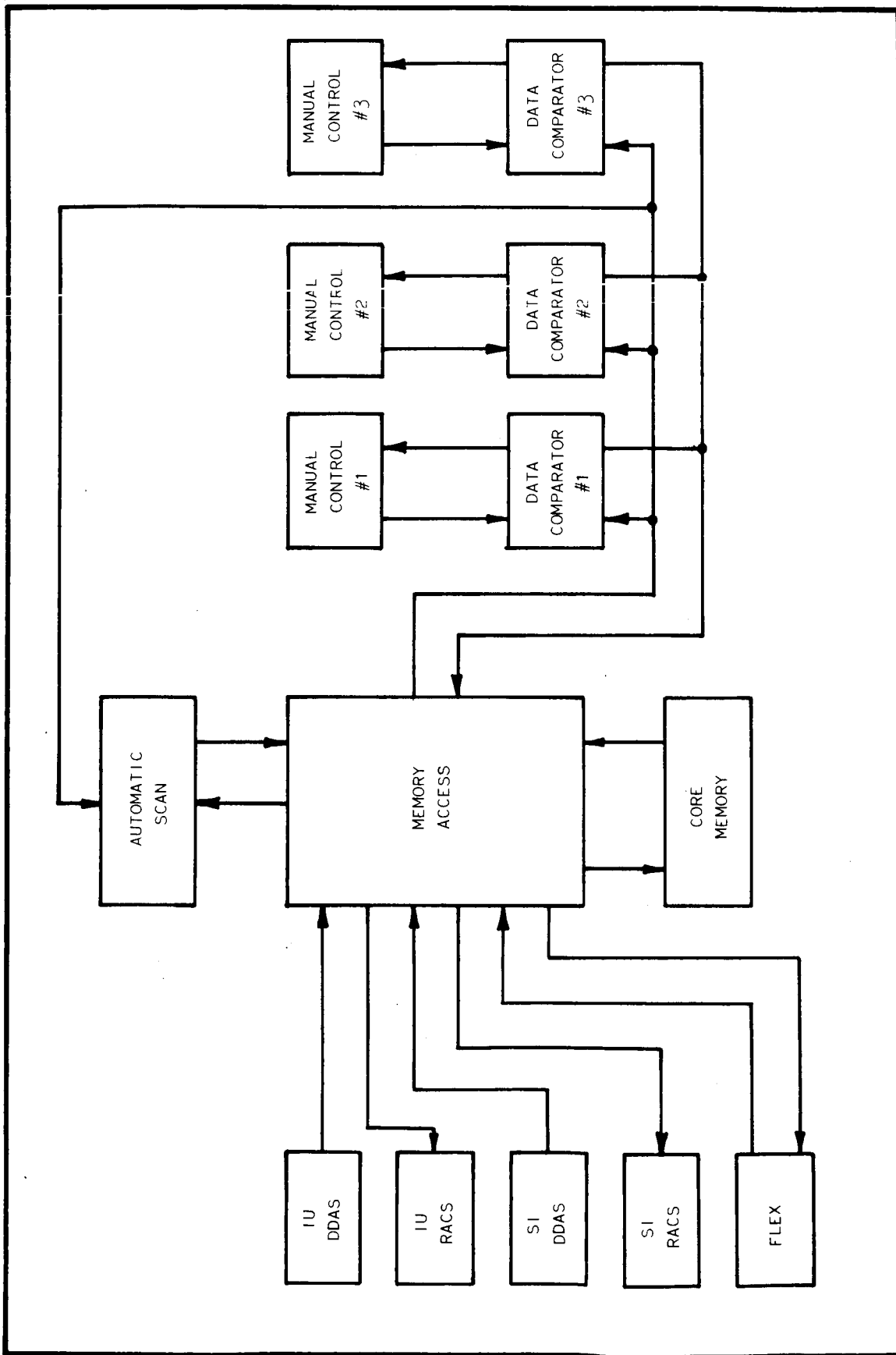


Figure 9 . Digital Data Calibration System, Block Diagram

tape or via punched cards from the IBM 407.) Each measurement in the Saturn system (except on single sideband) has an indirect address location in the Data Storage Unit (memory) and the required calibration information is stored in that location. This information includes:

- | | |
|---------------------|-------------------------------|
| 1. DDAS Address | 4. High Calibration Mode Data |
| 2. RACS Address | 5. Low Calibration Mode Data |
| 3. IU/S-I Selection | 6. Run Calibration Mode Data |

When a particular indirect address is selected in any mode, items 1, 2, and 3 are extracted from memory and executed. These three parts comprise the address portion of the calibration data. The actual calibration data (items 4, 5, or 6, depending on the calibration mode requested) is now extracted and set into the proper register. The calibration program accepts DDAS data from the selected DDAS station and makes a bit-by-bit comparison with the calibration data. The data is then converted to binary coded decimal and displayed on the control units during manual operation, or printed out on the Flexowriter or IBM 407 during automatic operation.

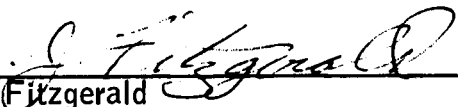
The 24 bit offset and DDCS scaling problems were formerly handled by loading the DDCS memory with values which compensated for the errors. The DDCS system has been modified for SA-9 and subsequent by addition of an arithmetic unit which eliminates the above problems. The correct values of expected voltages may now be loaded directly into the DDCS memory. Essentially the change amounts to subtracting 24 bits from the incoming DDAS value and multiplying the remainder by the proper scale factor to arrive at the actual measured value.

In addition to the arithmetic unit modification, an IBM interface drawer was added to the DDCS system. This drawer allows use of the IBM 407 machine to load the DDCS memory via punched cards and to print out the DDAS information in the automatic scan mode. Use of the IBM 407 to printout in the scan mode is advantageous to the operator as more information is presented on the IBM printout than is possible through use of the flexowriter.

APPROVAL

SP- 172

APPROVAL:


J.J. Fitzgerald
Chief, Measuring Branch, VE3

DISTRIBUTION

John F. Kennedy Center, NASA
Cocoa Beach, Florida

DIR	Dr. Debus, Siepert, Heiser (3)
E	Sendler
ED	Dr. Bruns
EF	White
EF2	Minderman
EF3	Hershey
EF4	Varnado
ES	Wilkinson
GA724	Technical Library (5)
M	Clark
ML	Gorman
MQ	Gramer
P	Petrone
PA	Claybourne
PA4	Mathews, Cope (2)
PA6	Body
PA72	Bishop
R	Harris
RP	Loy (2)
S	King
T	Dr. Knothe
V	Dr. Gruene, O' Hara, Zeiler (3)
VE	Williams (2)
VE3	Fitzgerald (2)
VE3	Tucker (2)
VG	Rigell
VM	Pickett
VT	Moser
VT2	Twigg
MT2523	Smith (5)

Scientific and Technical Information Facility
P.O. Box 5700, Bethesda, Maryland
Attn: NASA Representative, S-AK/RKT (2)

Total 49 copies